SLOVENSKI STANDARD
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Elektromagnetna združljivost in zadeve v zvezi z radijskim spektrom (ERM) ï Digitalne povezave VHF zrak-tla, 2. naļ in ï Tehniļne karakteristike in merilne metode za talno opremo ï 1. del: Fiziļna plast in podplast MAC

Electromagnetic compatibility and Radio spectrum Matters (ERM); VHF air-ground Digital Link (VDL) Mode 2; Technical characteristics and methods of measurement for ground-based equipment; Part 1: Physical layer and MAC sub-layer

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 1 of a multi-part deliverable covering VHF air-ground Digital Link (VDL) Mode 2; Technical characteristics and methods of measurement for ground-based equipment, as identified below:

Part 1: "Physical layer and MAC sub-layer";

Part 2: "Upper layers".

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Introduction

The present document states the technical specifications for ground-based equipment implementing Very High Frequency (VHF) Digital Link (VDL) Mode 2 air interface, operating in the VHF band (117,975 MHz - 137,000 MHz) with 25 kHz channel spacing.

Manufacturers should note that in the future, all or part of the frequency band 108,000 MHz to 117,975 MHz may become available for aeronautical communications.

The present document may be used to produce tests for the assessment of the performance of the equipment. The performance of the equipment submitted for type testing should be representative of the performance of the corresponding production model.

The present document has been written on the assumption that:

- the type test measurements will be performed only once, in an accredited test laboratory, and the measurements accepted by the various authorities in order to grant type approval;
- if equipment available on the market is required to be checked it may be tested in accordance with the methods of measurement specified in the present document.

1 Scope

The present document applies to VDL Mode 2 ground-air digital communications using Differential Eight Phase Shift Keying (D8PSK), intended for channel increments of 25 kHz. The VDL Mode 2 system provides data communication exchanges between aircraft and ground-based systems. The scope of the present document is limited to ground-based stations.

The VDL Mode 2 system is designed to be a Ground/Air sub-system of the Aeronautical Telecommunication Network (ATN) using the AM(R)S band and it is organized according to the Open Systems Interconnection (OSI) model (defined by ISO). It shall provide reliable subnetwork services to the ATN system.

The present document provides functional specifications for ground-based radio equipment intended to be used for ground-air data communications. The present document is derived from the following documents:

- VDL Mode 2 SARPs version 3.0. ICAO Annex 10 Volume III part I [1].
- ED 92a [2]: "MOPS for an Airborne VDL Mode-2 Transceiver Operating in the frequency range 118-136.975 MHz" (2003), which specifies the airborne transceiver.

The present document consists of two parts:

- the first part provides functional specifications and test procedures for physical layer and MAC sub-layer;
- the second part provides functional specifications and test procedures for link and sub-network access layers.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] Annex 10 to the Convention on International Civil Aviation: "Aeronautical Telecommunications".

[2] ED 92a (2003): "MOPS for an Airborne VDL Mode-2 Transceiver Operating in the frequency range 118-136.975 MHz".

[3] ISO/IEC 3309: "Information technology - Telecommunications and information exchange between systems - High-level data link control (HDLC) procedures - Frame structure".

[4] ISO/IEC 8208: "Information technology - Data communications - X.25 Packet Layer Protocol for Data Terminal Equipment".

[5] ISO/IEC 7498-1 (1994): "Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model".

[6] ISO/IEC 10731 (1994): "Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services".

[7] ETSI EN 300 113-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 1: Technical characteristics and methods of measurement".

[8] International Civil Aviation Organization (ICAO), Doc 9776: "Manual on VHF Digital Link (VDL) Mode 2".

3 Definitions and abbreviations

3.1 Definitions

3.1.1 Basic reference model definitions

The present document is based on the concepts developed in the open systems interconnect basic reference model and makes use of the following terms defined in ISO/IEC 7498-1 [5]:

- layer
- sublayer
- entity
- service
- service access point
- service data unit
- physical layer
- data link layer

3.1.2 Service conventions definitions

For the purposes of the present document, the terms and definitions given in ISO/IEC 10731 [6] apply:

- service provider
- service user
- service primitive
- request
- indication
- confirm

3.1.3 General definitions

For the purposes of the present document, the following terms and definitions apply:

adjacent channel power: amount of the modulated RF signal power transmitted outside of the assigned channel

NOTE: Adjacent channel power includes discrete spurious, signal sidebands, and noise density (including phase noise) at the transmitter output.

adjacent channel rejection: receiver's ability to demodulate the desired signal and meet the uncorrected BER requirement in the presence of an interfering signal in an adjacent channel

NOTE: The ratio (in dB) between the adjacent interfering signal level and the desired signal level necessary to achieve the specified minimum uncorrected BER, is the adjacent channel rejection (ACR) ratio.

aeronautical mobile service: mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate

average transmitter output power: average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long, compared with the lowest frequency encountered in the modulation, taken under normal operating conditions

Bit Error Rate (BER): ratio between the number of erroneous bits received and the total number of bits received

NOTE: The uncorrected BER represents the BER without the benefit of Forward Error Correction (FEC).

Co-Channel Interference (CCI): capability of a receiver to demodulate the desired signal and achieve the minimum specified BER performance in the presence of an unwanted signal at the same assigned channel

NOTE: The ratio (in dB) between the wanted signal level and the unwanted signal level is the co-channel interference ratio.

conducted measurements: measurements which are made using a direct rf connection to the equipment under test

data rate: VDL Mode 2 symbol rate shall be 10 500 symbols/s, with a nominal data rate of 31 500 bits/s

ground base station: aeronautical station equipment, in the aeronautical mobile service, for use with an external antenna and intended for use at a fixed location

interleaver: creates the AVPL_TIRS sequence made from the block segmentation of the AVLC frame and the RS encoding

NOTE: To this end one assumes the TIRS matrix made from the RS encoding of the AVLC block segmentation. The TIRS matrix is a matrix of octets made of 255 columns and c rows.

spurious emissions: conducted rf emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information

NOTE: Spurious emissions include parasitic emissions, intermodulation products and frequency conversion products.

X 25: ITU-T standard for the protocols and message formats that define the interface between a terminal and a packet switching network

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ABM	Asynchronous Balanced Mode
ACK	ACKnowledge(ment)
ACR	Adjacent Channel Rejection
ADM	Asynchronous Disconnected Mode
AGC	Automatic Gain Control
AM(R)S	Aeronautical Mobile (Route) Service
AMCP	Aeronautical Mobile Communications Panel
ATN	Aeronautical Telecommunication Network
AVLC	Aviation VHF Link Control
AVLC_LI	Aviation VHF Link Control Length Indicator
AVPL	Aviation VHF Physical Layer
AVPL-Header	AVPL Header and training sequence
AVPL-RBS	AVPL Received Bit de-Scrambled sequence
AVPL-RHeader	AVPL Reception Header
AVPL-RIRS	AVPL Received Interleaved and RS encoded sequence
AVPL-RSS	AVPL Received Symbol de-Segmented sequence
AVPL-TBS	AVPL Transmitted Bit Scrambled sequence
AVPL-THeader	AVPL Transmission Header sequence
AVPL-THI	AVPL Transmitted Header appended and Interleaved sequence
AVPL-TIRS	AVPL Transmitted Interleaved RS encoded sequence
AVPL-TTS	AVPL Transmitted Ternary Symbol sequence

AWG	Arbitrary Waveform Generator
BCD	Binary Coded Decimal
BER	Bit Error Rate
C/R	Command/Response (bit)
CCI	Co Channel Interference
CMD	CoMmanD (frame)
CRC	Cyclic Redundancy Check
CSC	Common Signalling Channel
CSMA	Carrier Sense Multiple Access
CW	Continuous Wave
D8PSK	Differentially encoded 8 Phase Shift Keying
dBc	Decibels relative to the carrier
dBi	Decibels relative to isotropic radiator
D-bit	ISO/IEC 8208 delivery bit
dBm	Decibels relative to 1 milliwatt
DCE	Data Circuit-terminating Equipment
DISC	DISConnect (frame)
DLE	Data Link Entity
DLS	Data Link Service
DM	Disconnected Mode (frame)
DTE	Data Terminal Equipment
DXE	Denotes either: Data terminal Equipment *or* Data circuit-terminating Equipment
EVM	Error Vector Magnitude
FCS	Frame Check Sequence
FEC	Forward Error Correction
FM	Frequency Modulation
FRM	Frame Reject Mode
FRMR	Frame Reject (frame)
GF	Galois Field
GSIF	Ground Station Information Frame
HDLC	High-level Data Link Control
Hex	Hexadecimal
HO	Hand-Off
HTC	Highest Two-way Channel
ICAO	International Civil Aviation Organization
ID	IDentification (identifier)
INFO	INFOrmation (frame)
IS	Intermediate System
ISH	Intermediate System Hello (packet)
ISO	International Organization for Standardization
ITU-R	International Telecommunication Union - Radiocommunication Sector
LCI	Logical Channel Identifier
LCR	Link Connection Refused
LME	Link Management Entity
Lsb	Least significant bit
LTC	Lowest Two-way Channel
M/I	Maintained/Initialized status bit
MAC	Media Access Control
Msb	Most significant bit
NET	Network Entity Title
nmi	Nautical miles
OSI	Open Systems Interconnection
P/F	Poll/Final (bit)
PDU	Protocol Data Unit
PN	Pseudo Noise
ppm	parts per million
Q-bit	ISO/IEC 8208 Qualifier bit
RF/rf	Radio Frequency
RIRS matrix	Reception de-Interleaver and RS-decoding matrix
RMS	Root Mean Square
RNR	Receive Not Ready (frame)
RR	Receive Ready (frame)

RS	Reed-Solomon
RSP	ReSPonse (frame)
SAP	Service Access Point
SARPS	Standards And Recommended PracticeS (ICAO)
SDL	Specification and Description Language
SDU	Service Data Unit
SINAD	(Signal + Noise + Distortion) / (Noise + Distortion)
SME	System Management Entity
SN	SubNetwork
SNAcP	SubNetwork Access Protocol
SNDCF	SubNetwork Dependent Convergence Function
SNPA	SubNetwork Point of Attachment
SNR	Signal to Noise Ratio
SNSAP	SubNetwork Service Access Point
SQP	Signal Quality Parameter
SREJ	Selective REJect (frame)
SRM	Sent selective Reject Mode
SVC	Switched Virtual Circuit
TIRS matrix	Transmission Interleaver and RS encoding matrix
UA	Unnumbered Acknowledgment (frame)
UI	Unnumbered Information (frame)
VDL	VHF Digital Link
VHF	Very High Frequency
VME	VDL Management Entity
VSA	Vector Signal Analyser
VSWR	Voltage Standing Wave Radio
XID	Exchange ID (frame)
XOR	Exclusive OR

4 General architecture of VDL Mode 2

The general architecture of the VHF radio equipment operating in VDL Mode 2 is depicted in figure 1. This figure presents the different functional parts of the VDL Mode 2 equipment.

The VDL system is related to the three lower layers of the OSI model providing services described as follows:

Layer 1 (Physical layer): provides transceiver frequency control, bit exchanges over the radio media, and notification functions. These functions are often known as radio and modulation functions. The physical layer handles information exchanges at the lowest level and manipulates bits. The physical layer handles modulation, data encoding and includes a forward error correction mechanism based on interleaving and Reed Solomon coding.

Layer 2 (Link Layer): is split into two sublayers and a link management entity:

- The MAC sublayer provides access to the Physical layer by a CSMA algorithm in charge of channel access. The MAC layer controls channel access and sharing.
- The DLS sublayer is composed of the AVLC derived from the HDLC protocol (ISO/IEC 3309 [3]) whose main functions are frame exchanges, frame processing, and error detection.
- The LME controls the link establishment and maintenance between DLS sublayers.

Layer 3: Only the lowest network sublayer of layer 3 (SNAcP) will be described in EN 301 841-2 (see bibliography). It is compliant with the subnetwork sublayer requirements defined in the ATN SARPs and conforms with the ISO/IEC 8208 [4] (or network layer of X.25). It provides packet exchanges over a virtual circuit, error recovery, connection flow control, packet fragmentation, and subnetwork connection management functions.

The DLS and LME part of the Layer 2 and Layer 3 are specified in EN 301 841-2 (see bibliography).

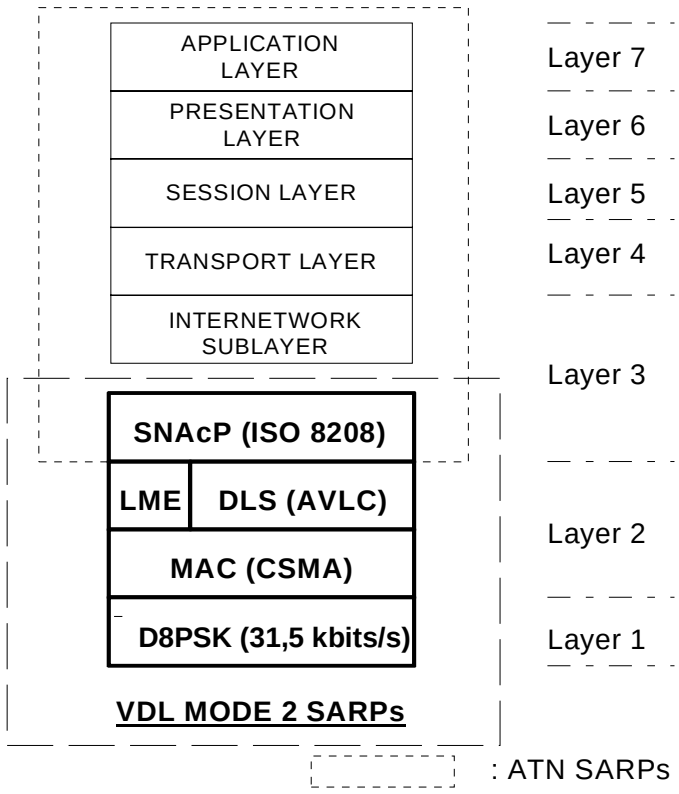

Figure 1: VDL SARPS in the ATN/OSI Organization

5 Physical layer protocols and services functional specifications

5.1 Overview

The ground stations shall access the physical layer operating in simplex mode.

5.1.1 Functions

The tasks of the physical layer include the following:

- to modulate and demodulate radio carriers with a bit stream of a defined instantaneous rate to create an rf link;
- to acquire and maintain bit and burst synchronization between Transmitters and Receivers;
- to transmit or receive a defined number of bits at a requested time (packet mode) and on a particular carrier frequency;
- to add and remove a training sequence;
- to encode and decode the Forward Error Correction scheme;
- to measure received signal strength;
- to decide whether a channel is idle or busy, for the purposes of managing channel access attempts;
- to offer a notification service about the quality of link.

5.1.2 Data reception by the receiver

The receiver shall decode input signals and forward them to the higher layers for processing.

5.1.3 Data transmission

The VDL physical layer shall appropriately encode the data received from the data link layer and transmit it over the rf channel.